

Transition to the ultimate regime in a radiatively driven convection experiment

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I will report on the transition between two regimes of heat transport in a radiatively driven convection experiment, where a fluid gets heated up within a tunable heating length ℓ in the vicinity of the bottom of the tank. The first regime is similar to the one observed in standard Rayleigh-Bénard experiments, the Nusselt number Nu being related to the Rayleigh number Ra through the power-law $Nu \sim Ra^{1/3}$ [1]. The second regime corresponds to the “ultimate” or mixing-length scaling regime of thermal convection [2,3], where Nu varies as the square-root of Ra . Evidence for these two scaling regimes have been reported in Lepot et al. [4], and I will present a detailed study of the transition from one regime to the other. I will introduce a simple model describing radiatively driven convection in the mixing-length regime, which leads to the scaling relation $Nu \sim \frac{\ell}{H} Pr^{1/2} Ra^{1/2}$, where H is the height of the cell and Pr the Prandtl number. From this model, one can deduce the values of Ra and Nu at which the system transitions from one regime to the other. These predictions are confirmed by the experimental data gathered at various Ra and ℓ [5].

Références

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